PATENT SPECIFICATION

448,815

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Complete Specification Accepted: June 16, 1936.

COMPLETE SPECIFICATION

Radiator Core for Cooling Liquids

I, Arthur Bernard Modine, of 17th and Racine Streets, Racine, State of Wisconsin, United States of America, a citizen of the United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention relates to radiator cores and has among its principal objects the provision of means whereby the temperature difference obtaining between the temperature of the air flowing through the core and the temperature of the heater elements of the core is maintained substantially uniform, in other words, the difference between the temperature of the air as it enters the radiator and the temperature of the heater elements of the core adjacent the front or receiving portion thereof is maintained substantially constant during the passage of the air through the core, the difference between the temperature of the air and the temperature of the heat exchange elements of the core remaining substantially the same at all times.

By way of further explanation, it may be said that the difference in temperature between the air as it enters the radiator and the temperature of the radiator elements at the receiving side of the radiator will correspond substantially to the difference in temperatures between the air and the heater elements at the point where the air leaves the radiator, and at all points therebetween.

Another object of the invention is the provision of a radiator core in which the proportion of direct to indirect heat transferring surface is increased toward the rear of the core.

The radiator core of the present invention is equipped in a known way with conduits providing fluid passages which are arranged relatively to each other to allow the air to circulate between the same. The novelty resides in the feature that the core has a relatively greater number of these tubes or conduits at the rear than at the front, whereby equalisation of temperature differential is maintained from the front to the rear of the core between the air and the tubes or conduits. It is also known to provide radiators of this type with fins which are frequently arranged transversely to the longitudinal extent of the conduits. The present invention also is characterized by providing a greater number of fins at the front than at the rear of the core, and this alteration in the spacing of the fins also serves for the maintenance of a substantially equal temperature differential from the front to the rear between the air of the fins. The fins are provided with means for creating turbulence of the air passing through the core, and these means are disposed transversely to the path of the air. The appearance of these turbulence creating means also varies from the front of the core to the rear of the same to vary the turbulence of the air in the same direction.

In the accompanying drawings:

Fig. 1 is a front elevation of a core involving the invention;

Fig. 2 is a section taken on line 2—2 of Fig. 1;

Fig. 3 is a view similar to Fig. 2 showing a modified construction in which tubes employed are of a flat cross section;

Fig. 4 is a view similar to Fig. 2 showing another modification and arrangement of tubes;

Fig. 5 is a sectional view of a fin or indirect heat radiating element preferably used in the forms shown in Figs. 1 to 4, inclusive, but which may be employed in any of the constructions shown. In this fin transverse corrugations are shown for increasing the area of the corrugated portion of the fin and also for producing turbulence. These corrugations have a maximum amplitude at the front of the radiator and decrease toward the rear as shown;

Figs. 6 and 7 are respectively plan and transverse sections of another modification which may be resorted to;

Figs. 8 and 9 are respectively plan and vertical sectional views of another modification that may be employed; and

Figs. 10 and 11 illustrate still another manner of accomplishing the invention,

[*Price* 1/-]

In the embodiment of the invention illustrated in Figs. 1 and 2, it will be noted that the tubes or passages generally designated 10 are arranged in rows extending from the front to the rear of the radiator, the rows being designated 11, 12 and 13 and it will be noted that the rearmost row 13 contains a greater number of tubes than the row 12 and that this last mentioned row contains more tubes than the first or front row 11 which provides means wherein the proportion of direct heat radiating means increases from the front to the rear of the core and will thus apply the greatest heat to the air circulating through the device as it is discharged from the device.

The invention also contemplates the association of heat radiating fins or indirect heating surfaces with the tubes or direct surfaces, said fins having means for engaging and turbulating air as it passes through the radiator from the front to the rear thereof.

These fins are generally designated 14 and are preferably provided with air engaging portions 15, the latter being provided to engage and cause turbulation of the air as it passes over said fins and between the tubes. It will be noted that the means 15 gradually decreases from the front to the rear of the fins and thus will cause the greatest turbulation near the point of introduction of air to the passages formed between said fins and tubes while turbulation is gradually decreased toward the rear of the core or at that portion of the core at which the greatest number of tubes is located. It is obvious that, as shown, in the forward part of each fin, viz., the front where the greatest amplitude of the corrugations is shown, the area and therefore the heat exchange surface is greatly increased per unit of length because of the corrugations and also that these corrugations will produce violent turbulence in the air passing between the fins.

The arrangement just referred to including the tubes and fins provides a means whereby the percentage of direct to indirect radiating surface is decreased at the front of the radiator where the cool air enters and is increased at the rear of the radiator where the heated air leaves or is discharged, resulting in maintaining a temperature differential between the elements and the air at the front and rear of the device, resulting in a radiator of higher heat transfer capacity having the same direct and indirect surfaces as prevailing types of these devices.

The structure shown in Fig. 3 involves the same principal as hereinbefore described only differing in that the tubes 16 of each row are of an elongated cross section and disposed at an angle to the tubes in an adjacent row. The structure shown in Fig. 4 contemplates an arrangement such as that above referred to and includes tubes 17 which are of an elongated cross section and are disposed in parallelism in rows 18, 19 and 20 with an increased number of tubes in the last mentioned row as explained in connection with Fig. 2. This last row of tubes may be narrower than the tubes of the preceding rows.

In Figs. 6 and 7 an arrangement is disclosed in which the ratio of direct to indirect heat transferring elements at the front portion of the core is comparatively low with a slightly higher ratio of direct to indirect heat transferring elements arranged immediately in the rear of the first mentioned set of tubes, the ratio being practically all direct at the rearmost set of tubes. The tubes in this arrangement are arranged in rows, the rows being designated 21, 22 and 23, the row 21 being provided with fins 24 in a manner to result in a low ratio of direct to indirect heat transferring surface at the front portion of the core or at the portion of the core at which air enters. The row of tubes 22 is provided with a lesser number of fins so that a higher ratio of direct to indirect heat transfer is accomplished at this portion of the structure. It will be noted that the rearmost set of tubes such as 23 have the least amount of indirect radiation associated therewith which results in practically all direct heat radiating surface at this point of the structure.

In the particular construction illustrated in Fig. 7, fins 25 and 26 extend from the tubes 22 to the tubes 23 whereas the fins 27 arranged between the fins 25 and 26 terminate short of the tubes 21 and 23. These fins such as 25, 26 and 27 may be provided with air engaging elements such as 15 referred to in Fig. 5.

In Figs. 8 and 9 is shown another arrangement which substantially corresponds to that hereinbefore referred to as to disposition of tubes and the number of tubes in each row and discloses another arrangement in which the proportion of direct to indirect surface is increased as the heat absorbing potential of the air decreases. This arrangement involves the use of tubes and fins, the latter of which are formed to provide means for turbulating air entering between the fins and tubes. In this last mentioned arrangement, fins 31 extend from the foremost or front tubes 28 to the center tubes 29 and certain of said fins such as

32 extend from the tubes 28 to the tubes 33, the fins 32 being spaced from each a suitable distance so as to accommodate a plurality of fins such as 31 in the space produced between said fins 32.

Figs. 10 and 11 show other arrangements or constructions which may be resorted to to accomplish the invention and contemplate an arrangement of tubes such as shown in Figs. 3 and 4 having fins or indirect heat radiating surfaces applied to the tubes. In this arrangement the proportion of direct surface to indirect surface is increased as the temperature difference between the cooling agent such as air and fluid to be cooled decreases, having means associated therewith for decreasing the degree of turbulence as the temperature difference or potential decreases. These structures contemplate arrangements similar to that hereinbefore referred to and may include fins such as those designated 34 and 35 which are constructed to provide oppositely extending projections 36 and 37, the projections decreasing in air engaging effectiveness from the front to the rear of the structure with the smaller projections located near the last row of tubes of the radiator and being practically devoid of any air turbulating means at these last mentioned tubes. These fins may be constructed as just referred to and may also include turbulating means such as 38 which in the present instance extend between the tubes of the last row. The fins may also include a structure such as that designated 39 which involves the use of a plurality of projections 40 which extend from one tube to the other and decrease in height from the foremost to the rearmost tube. The structure shown in Fig. 11 illustrates the use of corrugated fins 14^1, substantially like the fin illustrated at 14 in Fig. 5, in relation to substantially flat fins 41^1 of the character designated at 41 of Fig. 10.

From the foregoing description of the invention, it is evident that a means is provided whereby a substantially uniform temperature difference between the temperature of the air entering the device and the temperature of the elements forming the device is maintained at the inlet and outlet of said device. It is further evident that the arrangement is such that the percentages of direct to indirect surface is decreased at the front where the cool air enters and is increased at that point of the radiator where the heated air leaves or is discharged from the device and that the temperature differential is maintained by reason of a greater amount of direct surface being provided at the rear of the structure at which point said direct surface applied more heat and higher temperature to the indirect surface which results in a radiator of high heat transfer capacity without reduction of cooling capacity.

It is further manifest that by arranging the fluid passages or tubes such as 11, 12 and 13 with the greater number of tubes at the rear of the radiator, that this provides means which results in maintaining a substantially uniform temperature differential of the air flowing through the radiator. In addition, it is evident that by the utilization of heat radiating fins or indirect surfaces such as 14 having air turbulating means that the air is decreasingly turbulated from the point of introduction to the point of discharge of the air.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A radiator core in which tubular elements provide fluid passages and are arranged relatively to each other to allow air to circulate between said elements, characterized by the fact that the core has a relatively greater number of tubes at the rear than at the front thereof so as to provide means whereby substantially equal temperature difference is maintained from the front to the rear of the core between said air and the tubes.

2. A radiator core, as set forth in claim 1, including fins, there being a greater number of fins arranged at the front than at the rear of the core, whereby a substantially equal temperature difference is maintained from the front to the rear between the air and the fins.

3. A radiator core, as set forth in claims 1 and 2, including means on the fins for producing turbulence of air passing through the core, said turbulence creating means being arranged transversely to the path of the air.

4. A radiator core, as set forth in claims 2 and 3, wherein the turbulence creating means on the fins varies from the front to the rear of the device to decrease intensity of turbulence from the front to the rear of the core.

5. A radiator core, as set forth in claims 1, 2 and 4, wherein the differential arrangement of the turbulence creating means of the fins is selected to decrease the turbulence of the air towards the rear of the core for maintaining a substantially uniform temperature differential between the fins and the passing air at the front and rear of the core.

6. A radiator core, as set forth in

claims 1 and 2, including on the transverse fins corrugations of varying area, the area decreasing from the front towards the rear of the core to maintain a substantially uniform temperature difference.

7. A radiator core, as set forth in claim 1, wherein the fins are made of sheet metal plates with the turbulence producing means projecting from respectively opposite sides of the plates into the air as well as adjacent the opposite sides thereof.

8. A radiator core, as set forth in claims 1 and 2, wherein the means for creating turbulence of air are arranged in series extending substantially from the front edge portion of the plates to the rear edge portions thereof and decreasing in size progressively from the front to the rear ends of the series.

9. A radiator core, as set forth in claims 1 and 2, wherein the heating surfaces of the projections on the fins decrease from the front towards the rear of the core, and the heating surfaces of the tubes increase from the front towards the rear of the core.

10. A heat radiating fin for a radiator core, as set forth in claim 1, provided with variate air engaging turbulence creating means arranged transverse to the path of the air, the variate means varying from the front towards the rear of the fin with the means for creating the greatest turbulence located at the front of the fin.

11. A radiator core, substantially as described and shown, and for the purpose set forth.

Dated this 3rd day of June, 1935.

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Fig. 1.

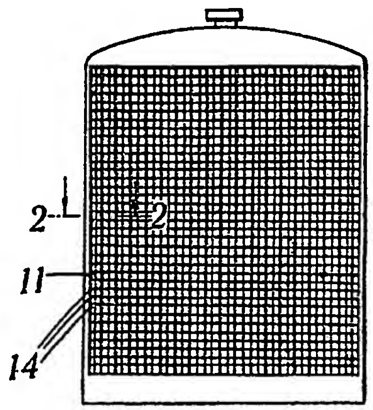

Fig. 2.

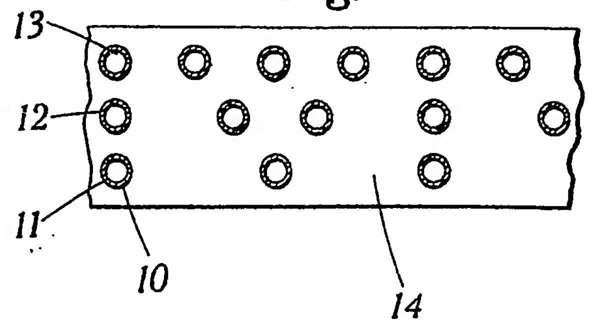

Fig. 3.

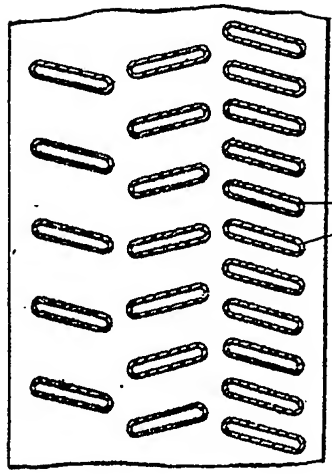

Fig. 4.

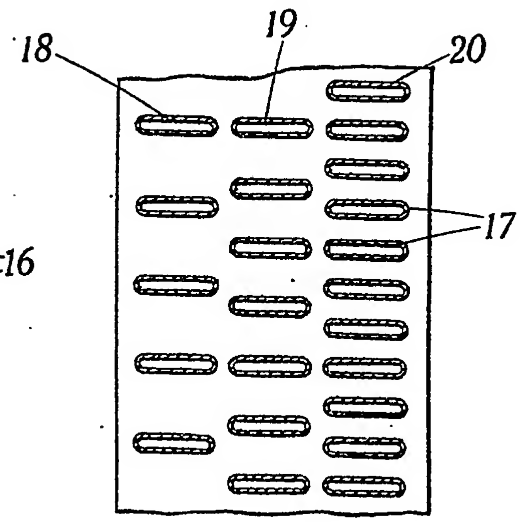

Fig. 5.

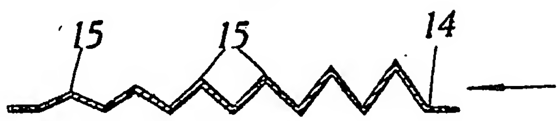

Fig. 6.

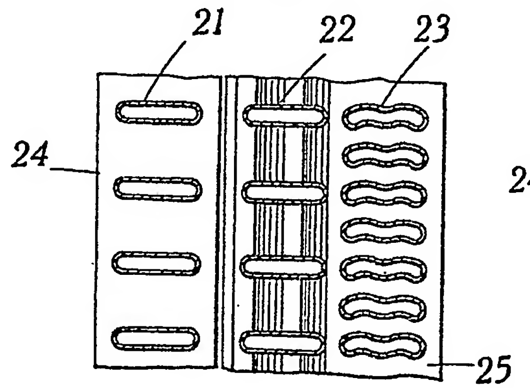

Fig. 7.

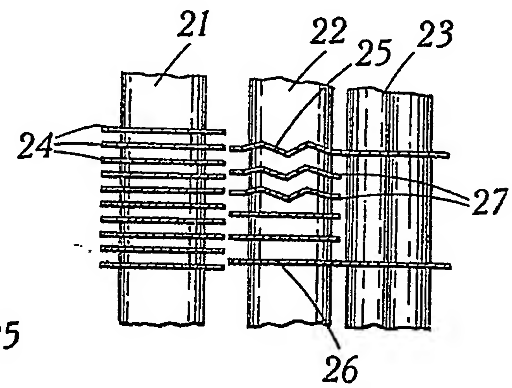

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Fig. 8.

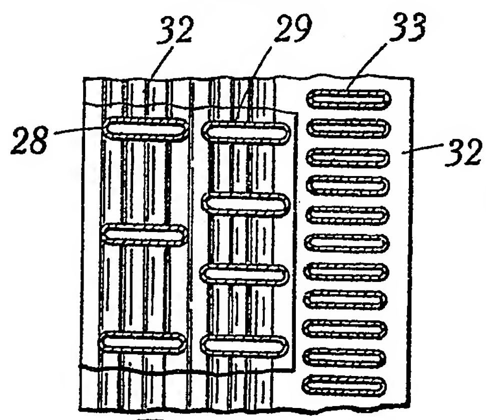


Fig. 9.

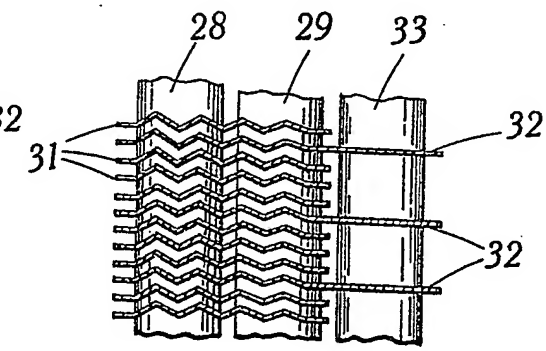


Fig. 10.

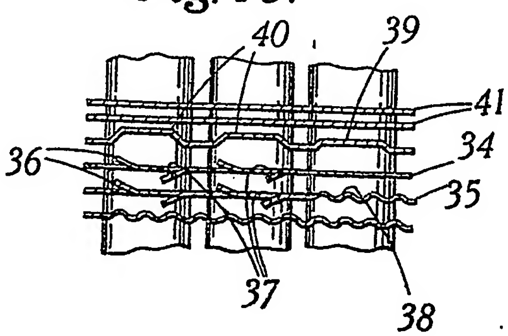
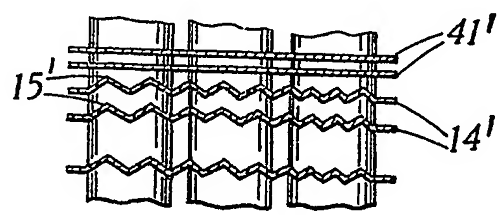


Fig. 11.



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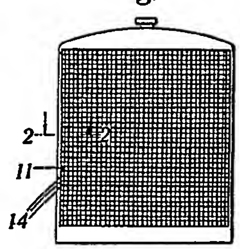

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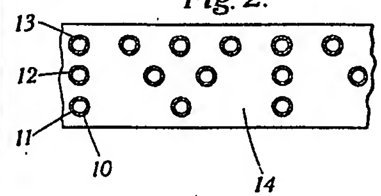


Fig. 3.

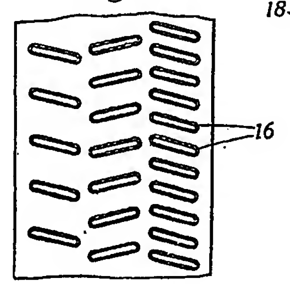


Fig. 4.

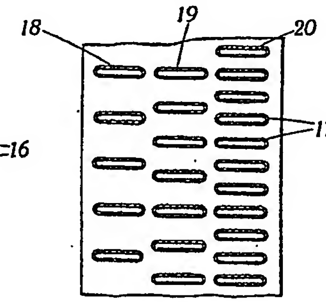


Fig. 5.

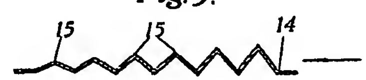


Fig. 6.

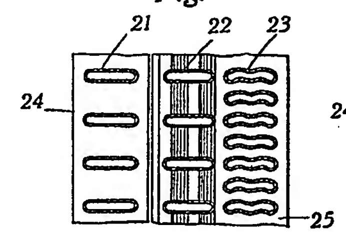
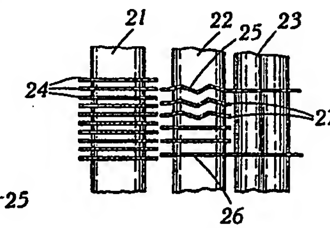


Fig. 7.



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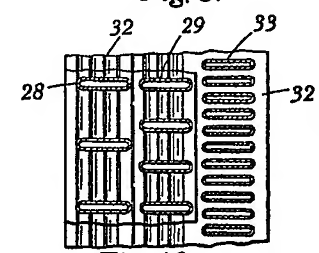
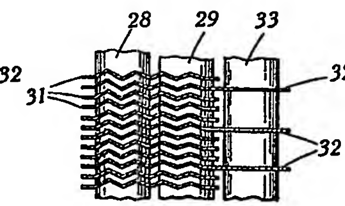


Fig. 9.



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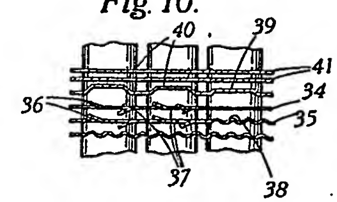

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